Mesic Soil Temperature Study in Lewis County, New York

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Abstract

The soil temperature regime in Lewis County, New York, has historically been in question. Although the soils have previously been correlated as being mesic, they were suspected as being frigid in some parts of Lewis County. Consequently, a network of eight sites was installed during 1997 to access the daily, monthly, seasonal, and annual temperature signatures in Lewis County. In addition to capturing soil temperature at 10 and 50 cm, an air temperature sensor collects ambient readings at each of the sites. Following retrieval of the temperature loggers, data were off-loaded and processed. All of the sites with annual data were substantiated as having a mesic soil temperature regime bordering to a frigid soil temperature regime. The average of the mean annual soil temperature at the sites is 8.4°F (47.1°F), the average summer soil temperature is 14.9°C (58.9°F), and the average winter soil temperature is 2.0°C (35.5°F). At 13.0°C (23.4°F), the tempered different between mean summer and mean winter soil temperature is conjectured to be a result of the winter snowfall in Lewis County. All of the sites are biologically inactive (<5°C) for five months at the 10-cm soil depth. The dates of biological inactivity during the study are nearly identical for each of the sites – from October 11th to April 12th.

Introduction and Purpose

There are many areas in the United States where the soil temperature is borderline to the frigid soil temperature regime. Soil Taxonomy defines the frigid soil temperature regime as having a mean annual soil temperature less than 8°C (46.4°F) (Soil Survey Staff, 1998). The question of the frigid soil temperature regime in upstate New York led to three sites in Lewis County being instrumented with air and soil temperature loggers in June 1997, and five additional sites installed in December 1997.

The Lewis County Global Change Project is part of the Remote Soil Temperature Network funded through the National Soil Survey Center (NSSC) in Lincoln, Nebraska. This network was initiated in 1996 to acquire a uniform soil temperature database for the entire United States. Hobo/StowAway temperature loggers were selected to capture soil temperature data from remote sites. The New York State Global Change Project was approved in 1997 to provide temperature data that will supplement current Global Change Projects from other study areas (Mount 1999).

The primary reasons for the Lewis County Global Change Project are --

1. To verify the mesic-frigid soil temperature regime separation in Lewis County, New York.
2. To identify the dates when the soils are below biological zero [5°C (41°F)] during the period of record at the 10-cm (4-in) soil depths.
3. To substantiate that the difference between mean summer soil temperature and mean winter soil temperature at 50 cm (20 in) is greater than 11.1°C (20°F).
4. To add to the growing collection of baseline soil temperature data for the Remote Soil Temperature Network.

Methods and Materials

The StowAway temperature loggers are used for all these projects. StowAway temperature loggers store 1,800 data points for periods ranging from 15 minutes to 360 days. Their calibrated temperature threshold is ±0.4°C (±0.7°F) and they are programmed to collect temperature data every 4 hours and 48 minutes for 360 days for the sites in Lewis County. This frequency of data capture is the same as five times each day. This equates to 16,200 air and soil temperature readings in Lewis County that were available for this study.

All of the sites in Lewis County are either in pasture, hayland, or woodland. Their latitudes range 43°32'1" to 43°41'32" and their longitudes range from 75°22'1" to 75°31'0" (Fig. 1).

Table 1 – Monthly and annual averages for soil temperature at five sites in Lewis County.

Analysis	#2 20" (C)	#3 20" (C)	#4 20" (C)	#5 20" (C)	#7 20" (C)	Means (C)
Jan	1.8	1.5	2.1	2.0	0.9	1.7
Feb	1.7	1.3	1.7	1.6	0.9	1.4
Mar	1.4	0.9	1.4	1.5	0.7	1.2
Apr	5.5	4.7	5.2	5.0	5.3	5.2
May	10.6	10.9	9.8	10.1	10.5	10.4
Jun	12.8	13.6	12.3	12.6	13.0	12.8
Jul	14.9	16.9	15.6	15.4	16.2	15.8
Aug	15.4	17.0	16.2	15.8	16.7	16.2
Sep	14.3	15.4	15.2	14.1	15.7	14.9
Oct	10.9	10.9	11.7	10.6	11.9	11.2
Nov	6.6	6.0	8.1	7.1	8.3	7.2
Dec	3.1	3.0	3.0	2.7	2.1	2.8
Analysis	#2 20" (C)	#3 20" (C)	#4 20" (C)	#5 20" (C)	#7 20" (C)	Means (C)
MAST	8.2	8.5	8.5	8.2	8.5	8.4
MST	14.4	15.8	14.7	14.6	15.3	14.9
MWT	2.2	1.9	2.3	2.1	1.3	2.0
MS-MW	12.2	13.9	12.4	12.5	14.0	13.0

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Methods and Materials, cont.

At each of the three sites, a 23-cm PVC pipe with a 10-cm diameter houses three StowAway temperature loggers and a desiccant pack to absorb excess moisture (Figs. 2-4). Holes drilled in the PVC pipe allow sensor leads to exit outside while the temperature loggers are protected from the weather elements. A hole was dug with a sharpshooter to a depth of 50 cm at each site. The soils were then examined to gather a taxonomic classification. One temperature sensor lead was tied to a tree sapling or fence post to capture air temperature and was generally placed about four feet above the soil surface. Two soil temperature sensor leads were installed at each site: one at the 10-cm soil depth and one at the 50-cm soil depth. Finally, the PVC pipe was thoroughly sealed, then buried at about 10 cm.

Results

Though eight sites were monitored for this study, annual data are available for only five of these sites. Figure 5 presents temperature data for the individual sites and Table 1 shows the monthly, seasonal, and annual results of the soil temperature averages at these sites.

For the 50-cm soil depth, March is the coldest month on average for the five sites in Lewis County. Conversely, August is the warmest month. At 10-cm, the coldest month is February and the warmest month is July. The average air temperature for this study is about 1°C warmer than the 30-year average at Lowville, the county seat of Lewis County. Most of this difference is during the winter months of this study. The average winter air temperature is -3.2°C (26.3°F) at the five sites and is -7°C (19.4°F) at Lowville. With snow acting as an insulator to buffer the winter soil temperatures, this air temperature difference is conjectured to have no impact on the average annual soil temperature.

The difference between the mean summer soil temperature and the mean winter soil temperature was greater than 11.1°C (20°F) (Fig. 6). This mean difference is 13°C (23.4°F). Consequently, for this period of record, our hypothesis was valid.

All of the sites are biologically inactive (<5°C or <41°F) for five months of each year at the 10-cm (4-in) depth. The dates of biological inactivity during the study are nearly identical for each of the sites – from October 11th to April 12th during the period of record (Fig. 7).

Data from a companion network at the same site from 1 January 1995 to 10 December 1998 indicates the period of biological inactivity to be (on average) 50 days longer than shown for the StowAway sensors for this study (Stein, 1999. Unpublished data. USDA-NRCS). These data suggest that the winter of 1997-1998 may have been warmer than normal.

Discussion

Each of the sites in the study area was measured by a different technology than the StowAway loggers during the same period of record (Stein, 1999. Unpublished data. USDA-NRCS). These thermistors indicated mean annual soil temperatures less than 8°C (46.4°F) in several cases. Moreover, these data suggest that many soils in Lewis County, New York, have a frigid temperature regime.

How do scientists present data that yield conflicting answers? For instance, Site 2 has a mean annual soil temperature of 8.2°C (47.1°F) during the period of record for the StowAway sensors but averages 6.6°C (43.9°F) during a longer period of record using a different set of thermistors.

Since every data collection device only, at best, approximates the truth, it is imperative that resolution of the calibration issue commence prior to installing data loggers. It is impractical to re-check all of the factory-calibrated sensors in the laboratory. This is especially true for temperature networks using hundred of sensors. Consequently, only a random spot-check of thermistors is deemed practical.

One way to spot check the calibration is to place a thermistor in an ice cube tray with tap water. Cool the water down to near freezing inside a refrigerator. Take the ice cube tray from the refrigerator and activate a data logger for a 15-minute test (Fig. 8).

The mean temperature of 1,800 readings for the ice cube test was -0.1°C (31.8°F). The sensor ranged from +0.1°C (32.2°F) to -0.4°C (31.3°F) for this 15-minute test. It was concluded that the calibration for this randomly selected sensor was accurate.

A thermistor may be accurately calibrated at the start of a study but lose its calibration before a study is complete. It has been documented from a soil temperature study in the Caribbean that nearly all thermistors begin to "drift" after three years (Mount, *et al.*, 1995). Consequently, thermistors need to be replaced every two years as is currently being done in the Remote Soil Temperature Network.

References

Mount, H.R., J. Davis, R. F. Paetzold, and M. Cortes-Colon. 1995. Climatic data for the Lameshur Bay Watershed, St. John Island for 1994. USDA-NRCS. Alpha Graphics, Lincoln, Nebraska. 32 pages.

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Acknowledgments

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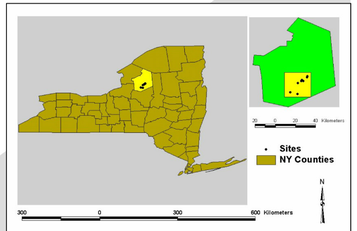

Figure 1. Location of the study area and temperature sites.

Figure 2. A small hole is dug to install the equipment.

Figure 3. The landscape at Site 3 is flat with no aspect influence.

Figure 4. The snowfall keeps the soil from freezing.

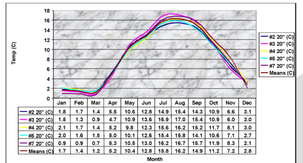

Figure 5. Mean monthly soil temperature data for Lewis County, New York.

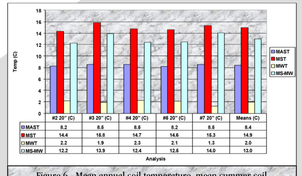

Figure 6. Mean annual soil temperature, mean summer soil temperature mean winter soil temperature, and the difference between mean summer and winter soil temperatures.

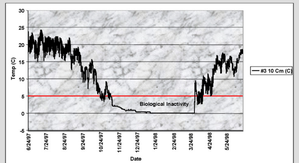

Figure 7. Temperature signature at 10 cm showing the period of biological inactivity for Site 3.

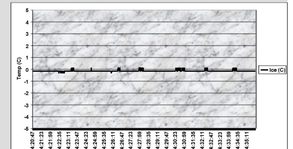

Figure 8. Calibration test on a StowAway XT1 sensor.